Supporting Information

Inorganic Polymer Photoresist for Direct Ceramic Patterning by Photolithography

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1. COSY, 1H-NMR, 13C-NMR,

Fig. 1s (a) COSY spectra of HM-PVS

Fig. 1s (b) 1H-NMR spectra of HM-PVS
2. Photopolymerization kinetic test

The mixture was prepared using 15 wt% synthesized polymer in CDCl₃ solvent, then 2-benzyl-2-(dimethylamino)-1-[4-(4-morpholinyl) phenyl]-1-butanone (Irgacure 369) as a photoinitiator was added (2 wt% of synthesized polymer). All samples were prepared in NMR tubes and then exposed in UV for 0, 10, 30, 60 sec. ¹H-NMR analysis was conducted immediately after illumination.

3. TGA data

![TGA curves for: initial solid PVS and HM-PVS](image)

Fig. 2s TGA curves for: initial solid PVS and HM-PVS
4. **Nano-indentation test**

For evaluation of mechanical property, the as-synthesized HM-PVS resin solution of 50 wt% in toluene was dropped onto 2x2 cm Si(100) wafers and then spun at 2000 rpm for 30 sec using a model PM101DT-R485 spinner (Head-way Research Inc.). The coating process was carried out inside a glove bag in a nitrogen or argon atmosphere to avoid the exposure to moisture. The polymer films were cured by UV exposure at 20 mW/cm² for 10 min and then annealed at various temperatures (100°C to 800°C) in a tube furnace in a nitrogen atmosphere at a heating rate 2°C min⁻¹, and then kept for 2 hrs. The modulus of the pyrolyzed films were evaluated by using Nano Indenter equipment (Nano Indenter XP, MTS) with low force to high force range and also include CSM mode.

![Graph](image)

**Fig. 3s** Dependence of Young’s modulus on various spin-coated films at differential temperatures

5. **Direct fabrication of ceramic structures via photolithography process**

5.1 **Mixture preparation**

The mixture was prepared using 25 wt% synthesized polymer in tetrahydrofuran anhydrous 99.9%, then 3 wt% of Irgacure 369 photoinitiator was added. After stirring, the 0.2 µm filters was used and the bubble in mixture must be removed for uniform coating layer.

5.2 **Fabrication of ceramic structures**

The photographic processes consist of (i) dynamic spinning of the mixture, (ii) 10 sec at 1000 rpm, and 30 sec at 2000 rpm, (iii) soft baking process for 2 min at 55°C, (iv) UV exposure at 30 mW/cm² for 40 sec (MA6 aligner, Karlsuss), (v) develop with ethanol for 15 sec at room temperature, (vi) Blow residual developer with N₂ gas, (vii) post bake process for 15 min at 110°C. Finally, the developed solid polymer samples were annealed in a tube furnace at 800°C in a nitrogen atmosphere for 2 hrs with a heating rate of 2°C min⁻¹ to produce the ceramic phase.